Technical Documentation

Lorain Products

RELTEC™

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LORAIN® MODEL HSB24HCAB
SPEC. NO. **588247500**

EQUIPPED WITH

LORAIN® MODEL HSB8HM, LIST 2
SPEC. NO. **486809800**

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Section 2992
October 7, 1996

Lorain Products / 1122 F Street / Lorain, Ohio 44052-2293 / (216) 288-1122

RELTEC™

LORAIN® MODEL HSB24HCAB LIST 1
SPEC. NO. 588247500
EQUIPPED WITH
LORAIN® MODEL HSB8HM LIST 2
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1. DESCRIPTION

General

1.01 The LORAIN® Model HSB24HCAB List 1 consists of an equipment cabinet which can accommodate one, two or three 8 ampere DC to DC converter plug-in modules (Model HSB8HM List 2). The equipment cabinet and plug-in modules comprise a DC to DC converter system which operates from nominal 48 volt DC input to provide filtered and regulated 140 volts DC to the load. The converter is designed with high frequency power conversion circuits to minimize audible noise levels. This converter requires rear access for all customer wiring connections.

1.02 The plug-in DC to DC converter modules operate from negative 48 volts DC. Either common or independent power sources may be used.

1.03 The converter module DC outputs may be used independently, or they may be paralleled with each other or with any "HSB" series DC to DC converter having the same output voltage rating. Paralleled converters may not share the load proportionately; however, current limiting circuitry in each converter will prevent damage to that converter. In addition, a series output diode is provided in each converter module which prevents a failed converter module from affecting operation of any paralleled converter.

1.04 Each plug-in converter module is equipped with high voltage shutdown and low voltage alarm circuits. Automatic converter shutdown results from a high output voltage condition. Manual restart is then required. If a low output voltage condition occurs, the converter remains operational, but local and remote alarms are activated.

1.05 A low battery voltage sensing circuit inhibits converter module operation and disables output to the load if input voltage decreases below 40 volts. The converter resumes operation automatically when input voltage reaches 42 volts.

1.06 Each plug-in converter contains output current limiting circuitry which automatically limits output current to a preset level.

2. TEST APPARATUS

2.01 The following list of tools and test equipment is sufficient to perform any test or adjustment procedure detailed in this instruction manual.

Test Equipment	Description
Digital Multimeter	Fluke Model 8022A or equivalent
Insulated Screwdriver	GC Electronics type 8728A or equivalent

3. INSTALLATION

Acceptance Checklist

3.01 This manual contains an acceptance checklist to help insure proper connection of the system. The acceptance checklist is located near the back of this manual just before the appendix.

Physical Considerations

3.02 Ventilation Requirements: This Modular DC to DC Converter System operates best in a well ventilated area with an ambient temperature range of –40°C (–40°F) to 65°C (149°F).

3.03 Mounting: The converter cabinet is designed for mounting in a 23 inch relay rack, and requires seven ?? inches of vertical rack space. If the DC to DC conveter is to be wired after the cabinet has been mounted, the area directly behind the converter must be open to facilitate customer wiring.

Electrical Connections

3.04 Converter module output polarity is selected by grounding either side of the output. Before making any wiring connections the rear cabinet cover must be removed. On the rear cover of DC to DC converter loosen the four cross head screws. Slide cover upward over screw heads then remove cover.

DANGER

This product requires a Safety Extra-Low Voltage (SELV) Input. A SELV input (based on the safety requirements for Information Technology Equipment Standards, such as UL1950, IEC 950) is a secondary circuit which is so designed and protected that under normal and single-fault conditions, the voltage between any two parts of the SELV circuit or circuits and for Class I equipment (provided with a protective earthing conductor from the building), between any one such part and the equipment protective earthing terminal does not exceed a safe value (42.4 V peak or 60 Vdc under normal conditions). It is separated from the primary or mains supply by Double (insulation comprising both Basic and Supplementary insulation) or Reinforced insulation (a single insulation system which provides a degree of protection against electric shock equivalent to Double insulation).

WARNING

Exercise extreme caution that correct polarity is observed when making input connections, or damage to the converter will result.

3.05 Input Connections: Terminal block (TB1) is provided for connection of customer furnished lugs. Refer to the Power Data sheet for recommended lug and wire size information.

Connect 48 VDC input for Converter Module 1 to the MOD 1 INPUT terminals (+) and (-). If two modules are

present, connect 48 volt DC input for Converter Module 2 to the MOD 2 INPUT terminals (+) and (-). If three modules are present, connect 48 VDC input for converter Module three to the MOD 3 input terminals (+) and (–). Observe proper polarity. The converter modules may be powered independently or from a common source. Refer to the INSTALLER'S CONNECTIONS and INSTALLER'S INFORMATION NOTES in the Power Data sheet for parallel or independent input wiring option information. The negative input lead(s) should be fused externally according to the recommendations in the Power Data sheet.

3.06 Output Connections: Terminal block (TB2) is provided for connection of customer furnished lugs. Refer to the Power Data sheet for recommended lug and wire size information.

Connect output leads for Converter Module 1 to the MOD 1 OUTPUT terminals (+) and (-). If two modules are present, connect 48 volt DC output for Converter Module 2 to the MOD 2 OUTPUT terminals (+) and (-). If three modules are present, connect 48 VDC output for converter Module three to the MOD 3 output terminals (+) and (–). Observe proper polarity. The converter module outputs may be connected in an independent or parallel configuration. Refer to the INSTALLER'S CONNECTIONS and INSTALLER'S INFORMATION NOTES in the Power Data sheet for parallel or independent output wiring option information.

3.07 Earth Ground Connection: The equipment cabinet is shipped with a Threaded stud and hardware for connection of a customer furnished lug. Refer to the Power Data sheet for recommended lug and wire size information.
The FRAME GROUND terminal, located behind the rear cabinet cover on the right side rear of the cabinet, is provided for connection to earth ground, if required.

Alarm Connections

3.08 Converter Fail Alarm: Connector J4 is located behind the rear cabinet cover and provides terminals for extending Converter Fail Alarms if required. Positive battery (ground) is supplied or removed from terminals of J4 during a failure condition as described below.

a) During normal operating conditions ground is provided on J4:

   Terminal 1 for Module 1
   Terminal 4 for Module 2
   Terminal 7 for Module 3

b) During a failure condition ground is provided on J4:

   Terminal 3 for Module 1
   Terminal 6 for Module 2
   Terminal 9 for Module 3

c) Ground is always provided at J4:

   Terminal 2 for Module 1
   Terminal 5 for Module 2
   Terminal 8 for Module 3

d) If extended open and closed loop alarm circuits are desired:

   Disconnect, sleeve, and tie back the brown wire connected to terminal 2 on J4 for module 1.

   Disconnect, sleeve, and tie back the white wire connected to terminal 5 on J4 for module 2.

   Disconnect, sleeve, and tie back the yellow wire connected to terminal 8 on J4 for module 3.

e) Extended form C alarm relay contacts of Converter Modules 1, 2 and 3 are now available at terminals of J4 as shown in Table 3-1.

Initial Startup and Checkout

3.09 General: After all electrical connections have been made, and before applying power to the converter cabinet, perform the following steps on each converter module present to ready the equipment for service.

a) Install the plug-in module into the equipment cabinet, and secure by tightening the fastening screw.

b) Place the Input Circuit breaker (CB1) to the ON position.

Converter Designation	Contact Status During Normal Converter Operation (Relay Energized)		Contact Status During Converter Failure Condition (Relay Released)	
	Open	Closed	Open	Closed
Module 1	J4-3 to J4-2	J4-1 to J4-2	J4-1 to J4-2	J4-3 to J4-2
Module 2	J4-6 to J4-5	J4-4 to J4-5	J4-4 to J4-5	J4-6 to J4-5
Module 3	J4-9 to J4-8	J4-7 to J4-8	J4-7 to J4-8	J4-9 to J4-8

Table 3-1

c) Perform Steps a) through b) for the second and third plug-in converter module if present.

d) Replace the rear cabinet cover that was removed in an eariler step. Make sure the two ground washers on the bottom screws are on the outside of rear cabinet cover. Tighten the four cross head screws. Refer to Figure 3-1.

3.10 Initial Startup

a) After making output polarity connections and installing the converter module(s) into the equipment cabinet, close the external protective or disconnect device(s) that supply input power to the DC-DC converter system.

b) Refer to Paragraph 5.02 to check converter module output voltage.

4. OPERATION

General

4.01 This LORAIN® Modular DC to DC Converter System operates from nominal 48 volts DC to provide filtered and regulated 140 volts DC to the load. Little if any operator intervention is required after installation. Periodic maintenance and adjustments are not normally required.

Starting and Stopping

4.02 To start or stop converter operation:

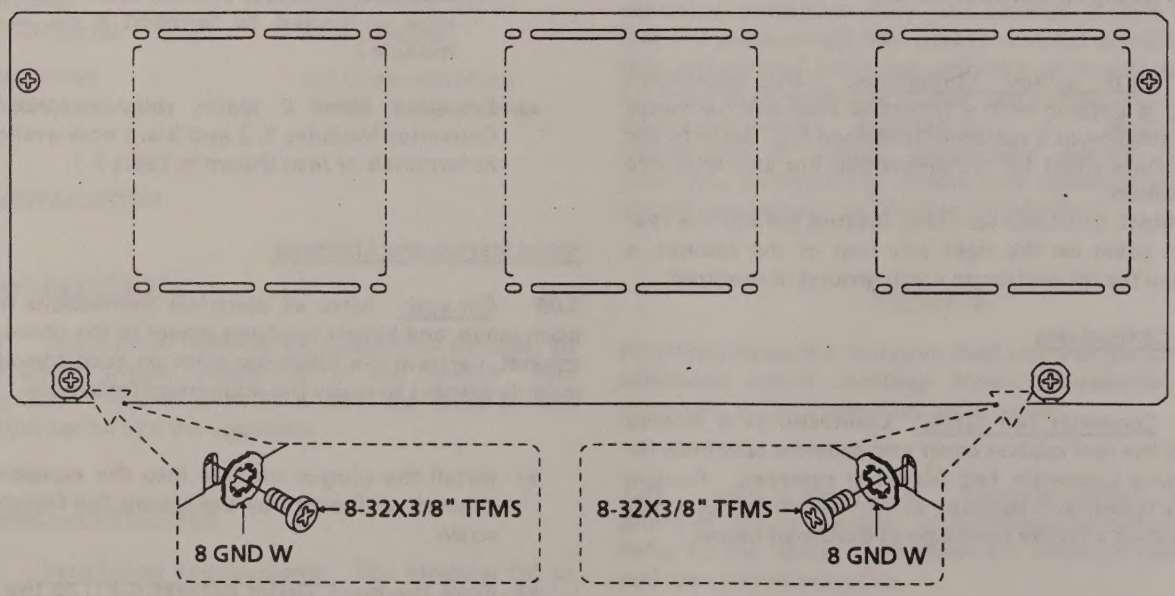


Figure 3-1 Rear Panel Ground Washer Locations.

a) Place Input Circuit breaker to the ON or OFF position.

b) Install or remove the converter module from the equipment cabinet with CB1 turned on.

DANGER

Upon removing an active converter module from its associated equipment cabinet, voltages capable of producing severe electrical shock will be present at various points throughout the module for a brief period of time. Therefore, do not contact any electrical termination until all LED indicators have extinguished after approximately 30 seconds.

Indicators

4.03 The following light emitting diode (LED) indicators, located on the front panel of each converter plug-in module, monitor the status of the module.

NOTE

All indicators described in the following will illuminate only when battery is supplied to the converter module input terminals and input circuit breaker (CB1) is in the ON position.

a) FAN FAIL ALARM: This red LED illuminates for any fan failure.

b) CONVERTER FAIL ALARM: This red LED illuminates for any of the following failure conditions:

1) Activation of fuse alarm circuit due to opening of output fuse.

2) Low voltage alarm due to low DC output voltage.

3) Converter output failure for any reason including high voltage shutdown or low battery inhibit.

4) Fan Failure

c) POWER ON: This green LED illuminates when 48 volts is applied to the converter input terminals and CB1 is in the ON position.

Test Jacks

4.04 OUTPUT VOLTAGE pin jacks are provided on each converter module front panel as a convenient point for connection of a high impedance DC voltmeter.

Alarms

4.05 Form C relay contacts are provided in each converter module for extending an alarm during a converter failure condition. These relay contacts are extended to connector J4, and supply or remove positive battery (ground) during a failure condition. Failure conditions are as follows.

a) Activation of fuse alarm circuit due to opening of output fuse.

b) Low voltage alarm due to DC output voltage decreasing below a preset limit. Unless otherwise specified, the low voltage alarm is factory set for 135.0 $\pm$0.5 volts.

c) Input voltage decreases below the factory set limit of 39 volts, which automatically inhibits converter operation.

d) Converter output failure for any reason, including high voltage shutdown or loss of DC input.

e) Fan Failure.

5. ADJUSTMENT

General

5.01 All control potentiometers intended for customer adjustment are located on the front panel of each plug-in converter module. Procedures for adjusting the output voltage and high voltage shutdown value are given in this section of the manual, and only these adjustments should be attempted by the user. Do not attempt to perform any adjustments not described in this section. Disturbing the settings of any factory-adjusted potentiometers may result in degraded equipment performance or complete failure.

DANGER

All adjustments are performed while the converter is operating. Hazardous voltages capable of producing severe electrical shock may be present at the output terminals and at the OUTPUT VOLTAGE test jacks. Exercise caution that contact is not made with any electrical termination, especially when connecting meter test probes. Remove watches, rings, and other jewelry before connecting test instruments and making adjustments. To further avoid the possibility of electrical shock or damage to the equipment, use only the insulated alignment tool recommended in the test equipment list when adjusting potentiometers.

Output Voltage Adjustment

5.02 Perform the following procedure to adjust converter output voltage. Unless otherwise specified the factory adjusted value is 143 ±0.5 volts.

a) Adjust a digital multimeter (DMM) to indicate 150 volts DC, and connect the test probes to the OUTPUT VOLTAGE test jacks located on the converter front panel. Observe correct polarity.

b) Set output load to 4 amperes.

c) Adjust potentiometer OUTPUT VOLTAGE clockwise for increased output voltage or counterclockwise for decreased output voltage.

d) When adjustment is completed, disconnect DMM test probes.

e) Repeat Steps a) through f) for the second and third converter modules if present.

High Voltage Shutdown Adjustment

5.03 Perform the following procedure to adjust the high voltage shutdown limit. Unless otherwise specified, the factory adjusted value is 150.0 ± 0.5 volts.

DANGER

In the following steps, upon removing an active converter module from its associated equipment cabinet, voltages capable of producing severe electrical shock will be present at various points throughout the module for a brief period of time. Therefore, do not contact any electrical termination until all LED indicators have extinguished after approximately 30 seconds.

a) Adjust a DMM to indicate 150 volts DC, and connect the test probes to the OUTPUT VOLTAGE test jacks on the converter front panel. Observe proper polarity.

b) Adjust potentiometer HV ADJ fully clockwise.

c) Note the output voltage value indicated by the DMM for later reference. Adjust potentiometer OUTPUT VOLTAGE for the output voltage value which equals the desired shutdown level.

d) Adjust potentiometer HV ADJ slowly counterclockwise until the converter inhibits as indicated by loss of DC output voltage.

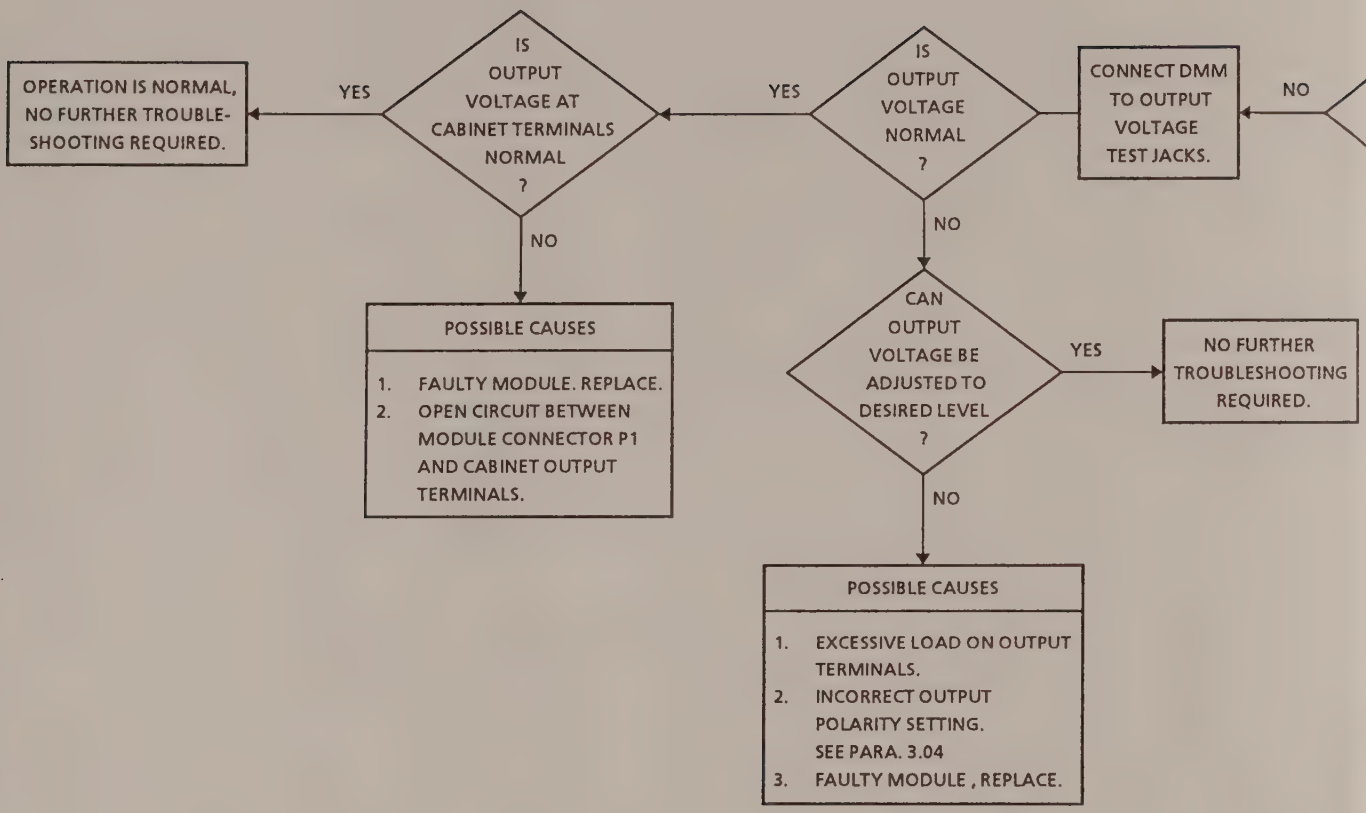
e) Adjust potentiometer OUTPUT ADJ counterclockwise approximately 1/4-turn. Restart the converter by placing CB1 to the OFF position for approximately 10 seconds then placing to the ON position.

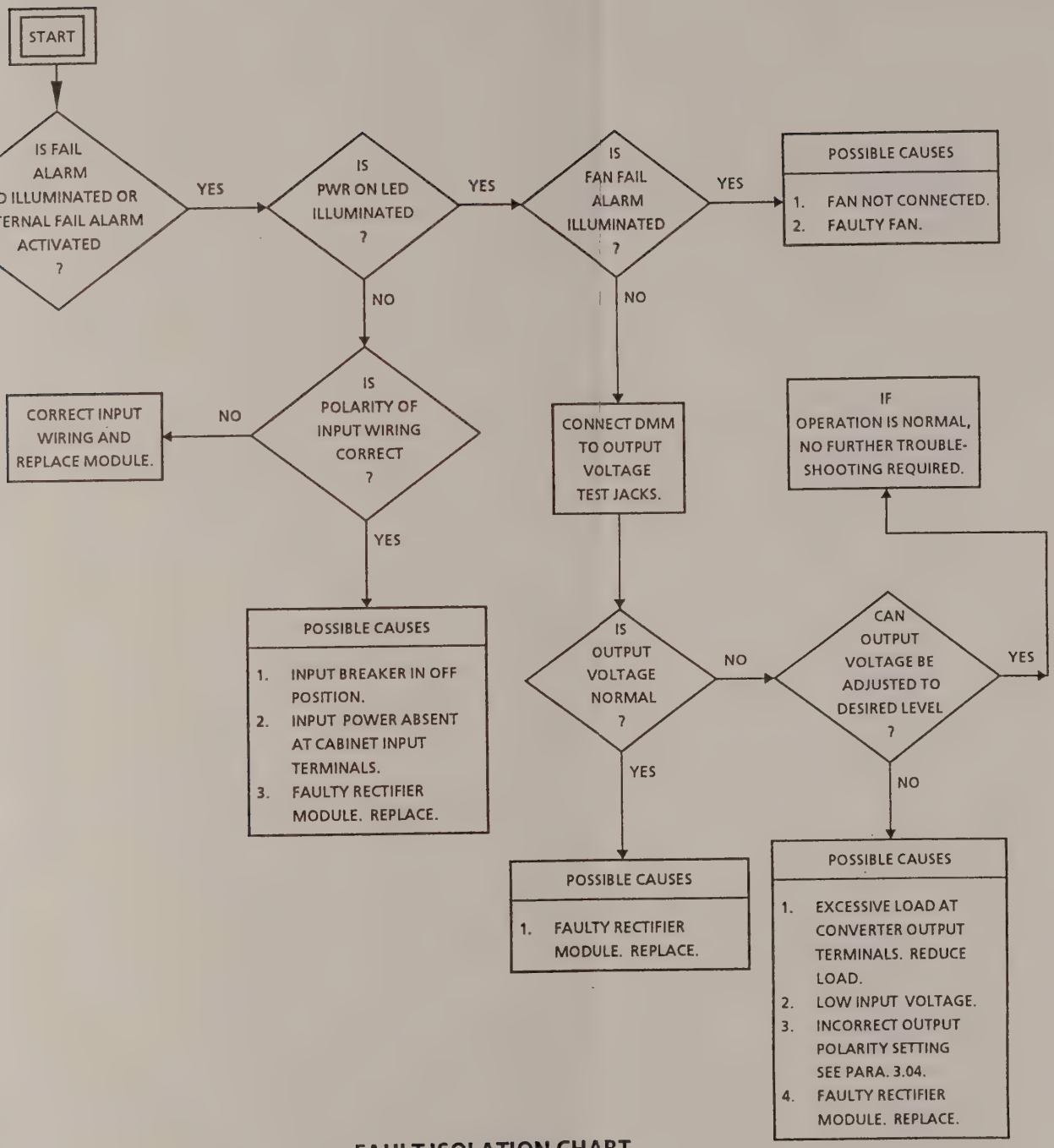
f) Note the output voltage indicated by the DMM while slowly adjusting potentiometer OUTPUT ADJ clockwise. Continue adjusting potentiometer OUTPUT ADJ until shutdown occurs, and note the shutdown voltage level.

g) If the shutdown voltage level is satisfactory, no further adjustment is required. If the desired voltage level is not attained, minor readjustment of potentiometer HV ADJ and repetition of Steps a) through f) are required.

h) When the desired shutdown level is attained, repeat Step e) and adjust potentiometer OUTPUT ADJ for the output voltage value originally noted in Step c).

i) When all adjustments are completed, disconnect the DMM test probes.


CONNECT DMM TO OUTPUT VOLTAGE TEST JACKS.
NO
IS OUTPUT VOLTAGE NORMAL ?
YES
NO
CAN OUTPUT VOLTAGE BE ADJUSTED TO DESIRED LEVEL ?
YES
NO FURTHER TROUBLESHOOTING REQUIRED.
NO
POSSIBLE CAUSES
1. EXCESSIVE LOAD ON OUTPUT TERMINALS.
2. INCORRECT OUTPUT POLARITY SETTING. SEE PARA. 3.04
3. FAULTY MODULE , REPLACE.
IS OUTPUT VOLTAGE AT CABINET TERMINALS NORMAL ?
YES
NO
POSSIBLE CAUSES
1. FAULTY MODULE. REPLACE.
2. OPEN CIRCUIT BETWEEN MODULE CONNECTOR P1 AND CABINET OUTPUT TERMINALS.
OPERATION IS NORMAL, NO FURTHER TROUBLE-SHOOTING REQUIRED.


START
IS FAIL ALARM D ILLUMINATED OR TERNAL FAIL ALARM ACTIVATED ?
YES
IS PWR ON LED ILLUMINATED ?
YES
IS FAN FAIL ALARM ILLUMINATED ?
YES
POSSIBLE CAUSES
1. FAN NOT CONNECTED.
2. FAULTY FAN.
NO
NO
IS POLARITY OF INPUT WIRING CORRECT ?
NO
CORRECT INPUT WIRING AND REPLACE MODULE.
YES
POSSIBLE CAUSES
1. INPUT BREAKER IN OFF POSITION.
2. INPUT POWER ABSENT AT CABINET INPUT TERMINALS.
3. FAULTY RECTIFIER MODULE. REPLACE.
CONNECT DMM TO OUTPUT VOLTAGE TEST JACKS.
IF OPERATION IS NORMAL, NO FURTHER TROUBLE-SHOOTING REQUIRED.
IS OUTPUT VOLTAGE NORMAL ?
NO
CAN OUTPUT VOLTAGE BE ADJUSTED TO DESIRED LEVEL ?
YES
YES
NO
POSSIBLE CAUSES
1. FAULTY RECTIFIER MODULE. REPLACE.
POSSIBLE CAUSES
1. EXCESSIVE LOAD AT CONVERTER OUTPUT TERMINALS. REDUCE LOAD.
2. LOW INPUT VOLTAGE.
3. INCORRECT OUTPUT POLARITY SETTING SEE PARA. 3.04.
4. FAULTY RECTIFIER MODULE. REPLACE.

FAULT ISOLATION CHART
MODEL HSB8HM
SPEC. NO. 588247500

6. TROUBLESHOOTING

General

6.01 The fault isolation chart included in these instructions is designed to aid service personnel in locating possible failures in the converter.

The chart is in the form of a flow diagram containing interrogatory and directive statements in diamond-shaped and rectangular geometric figures, respectively. A yes or no response sufficiently answers each inquiry, and the servicing technician should follow the respective YES or NO line of flow to the next inquiry or directive statement. The directive statements require that the technician perform an adjustment or test to verify certain operational conditions. If the line of flow terminates in a block entitled POSSIBLE CAUSES, the servicing technician should check each cause listed and take appropriate corrective action if a possible fault condition is located.

Repair and Replacement Information

6.02 If the suspected cause of a trouble symptom is an out of adjustment condition, the particular adjustment setting should be checked or reset using the appropriate adjustment procedure.

6.03 When a trouble symptom is localized to a faulty plug-in module, that module should be replaced. No attempt should be made to troubleshoot or repair individual converter modules.

7. MODEL DATA

General

7.01 Refer to the Power Data sheet for information concerning input and output ratings, operating limits, dimensions, and wiring information.

ACCEPTANCE CHECKLIST

The following list can be used to help verify that all System installation, wiring options, and input/output connections have been completed. Check off each procedure as it is completed.

- ☐ 1) Verify Physical Considerations (Section Three).
- ☐ 2) Verify Electrical Connections (Section Three).
- ☐ 3) Verify Alarm Connections (Section Three).
- ☐ 4) Verify Initial Startup and Checkout (Section Three).

APPENDIX

RECORD OF INSTRUCTION CHANGES		
ISSUE OR DATE	PRN	DESCRIPTION OF CHANGE
A1	-	New

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In Canada :
RELTEC Canada
122 Edward St. / St. Thomas, Ontario N5P 1Z2 / (519) 631-0780
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Productos Lorain de Mexico S.A. de C.V.
Apartado Postal 77001 / Mexico 10 D.F., MX 11200 / (905) 576-8277

1. SPECIFICATION

1.1 GENERAL: The LORAIN® Model HSB8HM List 1 consists of an equipment cabinet which can accommodate one, two, or three 8 ampere DC to DC converter plug-in modules (Model HSB8HM List 2). The equipment cabinet and plug-in modules comprise a DC-DC Converter System which operates from nominal 48 volt DC input to provide filtered and regulated 140 volts DC to the load. DC output is isolated from the DC input. This equipment is designed for operation with either the positive or negative output grounded. Refer to Table 1.1 for a summary of the numbering scheme. The equipment is finished in off white.

MODEL NO.	LIST NO.	SPEC. NO.	DESCRIPTION
H8B24HCAB	1	588247500	CABINET
HSB8HM	2	486809800	8 AMP. MODULE

TABLE 1.1

1.2 OUTPUT RATINGS

1.2.1 Voltage: Negative or positive 140 volts DC nominal. Adjustable over the range of 125.0 to 145.0 volts.

1.2.2 Regulation

(A) Static: Steady state output voltage remains within ±1% of the adjusted voltage for any load current from no load to full load over the input voltage range of 42 to 57 volts DC.

(B) Dynamic: For any step load change within the range of 10% to 100% of full rated output current, the maximum voltage transient will not exceed ±2% of the initial steady state voltage. For any load change from no load to full load, the maximum voltage transient will not exceed ±5% of the initial steady state voltage. Refer to Paragraph 1.8.1.

1.2.3 Filtering: The following parameters apply for the temperature range of -20°C to +65°C (-4°F to +149°F)

(A) Voice band noise is less than 40 dBrn when measured at the output terminals with a noise meter using 600 ohm bridged input and C-message weighting. Refer to Paragraph 1.8.1.

(B) Wide band noise does not exceed 500 millivolts peak to peak over the frequency range of 10 Hz to 50 MHz. Refer to Paragraph 1.8.1.

(C) Wide band noise does not exceed 100 millivolts rms over the frequency range of 10 Hz to 50 MHz. Refer to Paragraph 1.8.1.

1. SPECIFICATION

1.2 OUTPUT RATINGS (CONT)

1.2.4 Current

(A) With one converter module installed, 8 Amperes, two converter modules installed, 16 Amperes, three converter modules installed, 24 Amperes.

1.3 INPUT RATINGS

1.3.1 **Voltage:** 48 volts DC positive ground, with operational range of 42 to 57 volts DC.

1.3.2 **Filtering:** The following measurement is valid for the temperature range of -20°C to +65°C (-4°F to +149°F)

(A) Voice band noise is less than 21 dBrn when measured at the input terminals with a noise meter using 600 ohm bridged input and C-message weighting. Refer to Paragraph 1.8.1.

1.3.3 **SELV:** This product requires a Safety Extra-Low Voltage (SELV) Input. A SELV input (based on the safety requirements for Information Technology Equipment Standards, such as UL1950, IEC 950) is a secondary circuit which is so designed and protected that under normal and single-fault conditions, the voltage between any two parts of the SELV circuit or circuits and for Class I equipment (provided with a protective earthing conductor from the building), between any one such part and the equipment protective earthing terminal does not exceed a safe value (42.4 V peak or 60 Vdc under normal conditions). It is separated from the primary or mains supply by Double (insulation comprising both Basic and Supplementary insulation) or Reinforced insulation (a single insulation system which provides a degree of protection against electric shock equivalent to Double insulation).

1.3.4 **Typical Input Data- when equipped with one converter module.**

(A) 140 volts at the converter output terminals.

DC Input Voltage	Percent of Full Load	Input Current (Amperes)	Efficiency (%)
42	0	0.4	-
	25	7.8	89.9
	50	14.9	91.3
	75	22.6	90.9
	100	30.3	90.0
48	0	0.4	-
	25	6.9	89.1
	50	13.1	90.8
	75	19.8	91.2
	100	26.2	90.0
57	0	0.4	-
	25	5.9	87.4
	50	11.1	90.9
	75	16.7	90.7
	100	22.1	90.5

(B) Maximum input current does not exceed 33.0 amperes at 105% load with input voltage at 42 volts and 145 volts at the converter output terminals.

1. SPECIFICATION

1.3 INPUT RATINGS (CONT)

1.3.5 Typical Input Data- when equipped with two converter modules with paralleled inputs.

(A) 140 volts at the converter output terminals.

DC Input Voltage	Percent of Full Load	Input Current (Amperes)	Efficiency (%)
42	0	0.7	-
	25	15.6	89.9
	50	29.8	91.3
	75	45.3	90.9
	100	60.5	90.0
48	0	0.8	-
	25	13.7	89.1
	50	26.2	90.8
	75	39.6	91.2
	100	52.5	90.0
56	0	0.9	-
	25	11.8	87.4
	50	22.2	90.9
	75	33.4	90.7
	100	44.1	90.5

(B) Maximum input current does not exceed 66.0 amperes at 105% load with input voltage at 42 volts and 145 volts at the converter output terminals.

1.3.6 Typical Input Data - when equipped with three converter modules with paralleled inputs.

(A) 140 volts at the converter output terminals.

DC Input Voltage	Percent of Full Load	Input Current (Amperes)	Efficiency (%)
42	0	1.1	-
	25	23.4	89.9
	50	44.7	91.3
	75	67.9	90.9
	100	90.8	90.0
48	0	1.2	-
	25	20.6	89.1
	50	39.3	90.8
	75	59.4	91.2
	100	78.7	90.0
56	0	1.3	-
	25	17.7	87.4
	50	33.3	90.9
	75	50.0	90.7
	100	66.2	90.5

(B) Maximum input current does not exceed 99.0 amperes at 105% load with input voltage at 42 volts and 145 volts at the converter output terminals.

1. SPECIFICATION

1.4 STANDARD FEATURES

1.4.1 Input Protection

(A) A DC input circuit breaker present in each module opens the negative input lead. This input lead should be fused externally according to the recommendations of INSTALLER'S INFORMATION NOTE 4.1.

(B) A low battery voltage sensing circuit in each module automatically inhibits converter operation if input voltage decreases below 40 volts. Converter operation resumes automatically before input voltage reaches 42 volts.

1.4.2 Output Protection

(A) **Current Limiting:** At nominal input voltage, output current is automatically limited to a preset adjustable level. Unless otherwise specified, the current limit is factory set at 105% of full rated load.

(B) **Overvoltage Shutdown:** The converter module will shut down if output voltage increases above a preset value. Unless otherwise specified, the overvoltage shutdown level is factory set at 150 volts DC.

(C) **Series Output Diode:** A series output diode, enables paralleling with other converters. Load may not share proportionally between parallel connected units.

1.4.3 **Alarms:** Each converter module contains circuitry for extending alarms during a failure condition. Relay contacts of extended alarm circuits are rated for 1 ampere at 60 volts DC. Refer to Section 3. INSTALLER'S CONNECTIONS and Section 4. INSTALLER'S INFORMATION NOTES of this Power Data sheet for a description of the extended relay contacts.

(A) **Converter Fail Alarm:** Form C relay contacts are provided for the connection of external alarms if one or more of the following failure conditions occur. These relay contacts are extended to connector J4, and supply or remove positive battery (ground) during a failure condition.

(1) Activation of fuse alarm circuit due to opening of output fuse.

(2) Low voltage alarm due to DC output voltage decreasing below a preset limit. Unless otherwise specified, the low voltage alarm is factory set for 135.0 $\pm$0.5 volts.

(3) Input voltage decreases below the factory set limit of 39 volts, which automatically inhibits converter operation.

(4) DC output failure for any reason, including an overvoltage shutdown, or loss of DC input.

(5) Fan failure.

1.4.4 **Indicators:** The following light emitting diodes (LED's) provide local visual indication of the operating status of each converter module. These indicators are located on the front panel of the module unless otherwise specified. NOTE: Indicators will not illuminate unless battery is present at converter module input terminals and the input circuit breaker is on.

1. SPECIFICATION

1.4 STANDARD FEATURES (CONT)

(A) POWER ON: This green LED illuminates when DC input power is present and the input circuit breaker is on.

(B) CONV FAIL ALARM: This red LED illuminates if a converter failure condition occurs. Failure conditions include opening of output fuse, low voltage alarm, converter output failure, low battery inhibit, and fan failure.

(C) Fan Fail Alarm: This red LED illuminates and the converter fail alarm is activated if the fan fails.

1.4.5 Meter Test Points: OUTPUT VOLTAGE test jacks, located on each converter module front panel, are provided as a convenient method for connecting an external high impedance DC voltmeter.

1.4.6 Mounting: The equipment cabinet is designed for mounting in a 23 inch relay rack with 1 inch or 1 - 3/4 inch multiple mounting holes. Refer to ENVIRONMENTAL RATINGS in this Power Data sheet for further mounting location considerations.

1.5 ENVIRONMENTAL RATINGS

1.5.1 Operating Temperature Range: -40°C to +65°C (-40°F to +149°F)

1.5.2 Storage Temperature Range: -40°C to +65°C (-40°F to +149°F).

1.5.3 Humidity: This DC-DC converter system is capable of operating in an ambient relative humidity range of 0% to 95%, noncondensing.

1.5.4 Altitude: The maximum ambient operating temperature should be derated by 10°C at an elevation of 10,000 feet above sea level. For elevations between 3,000 feet and 10,000 feet, derate the maximum operating ambient temperature linearly.

1.5.5 Heat Dissipation: With output adjusted to 140 volts DC at rated full load and 48 volts input:

Number Of Modules	Shelf Output Current (Amps)	BTU/Hr
1	8	550
2	16	1100
3	24	1650

1.5.6 Ventilation Requirements:

(A) The converter cabinet should be mounted so that ventilating openings are not blocked and temperature of the air entering the cabinet does not exceed +65°C (+122°F).

1.5.7 Audible Noise: Operating frequency is beyond the audible range.

1.5.8 EMI/RFI Suppression: This unit conforms to the radiated noise requirements of FCC rules Part 15, Subpart B, for Class A computing devices. Additionally, conducted EMI on the DC input and output leads conforms to the requirements of Bellcore PUB 1089. Refer to Paragraph 1.8.1.

1. SPECIFICATION

1.6 ACCESSORIES

1.6.1 Bus bar shorting adapter: This accessory provides two shorting adapters to convert three inputs into one. Specify one (1) of Part No. 418140800.

1.7 RELATED DOCUMENTATION

1.7.1 Schematic Diagram: SD588247500

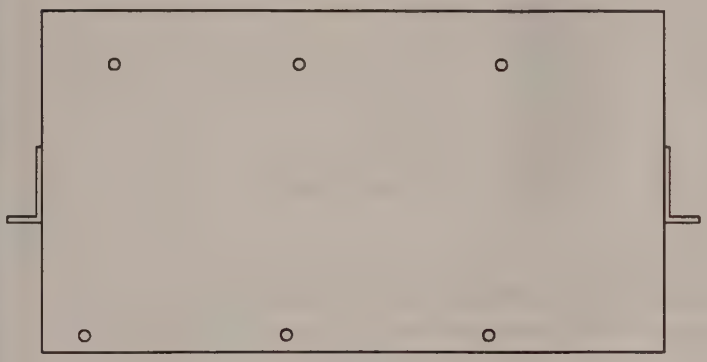
1.7.2 Wiring Diagram: T588247500

1.7.3 Instructions: Section 5639

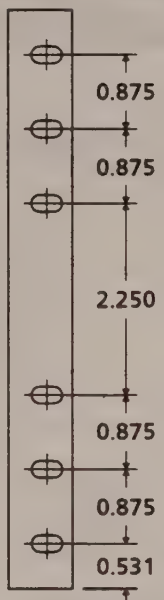
1.8 SPECIFICATION NOTES

1.8.1 This parameter is guaranteed by engineering design and test, and is not production tested.

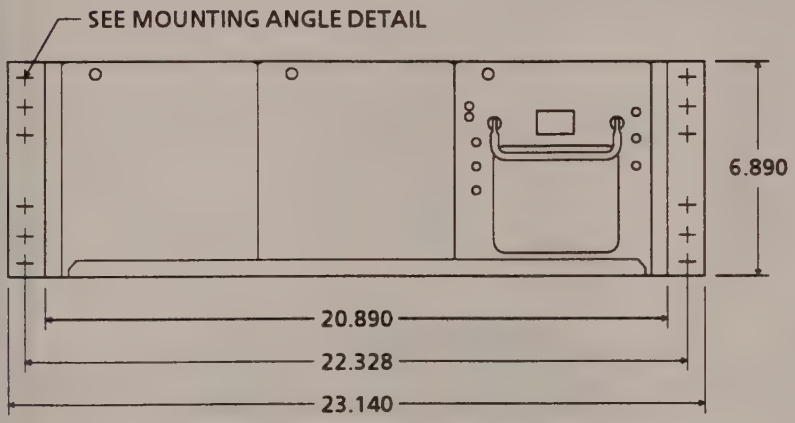
2. DIMENSIONS



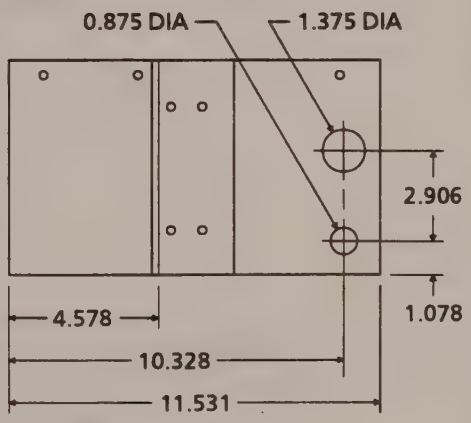
TOP VIEW



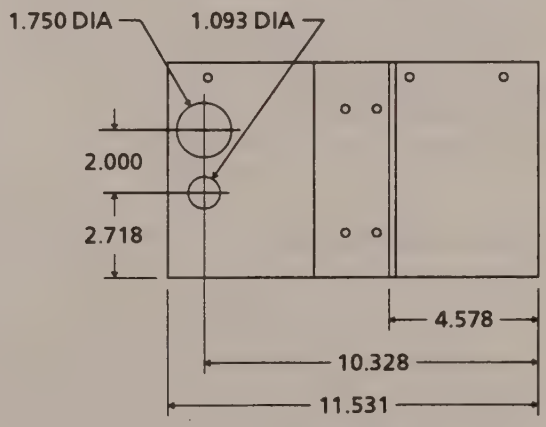
MOUNTING ANGLE DETAIL



FRONT VIEW



R. SIDE VIEW

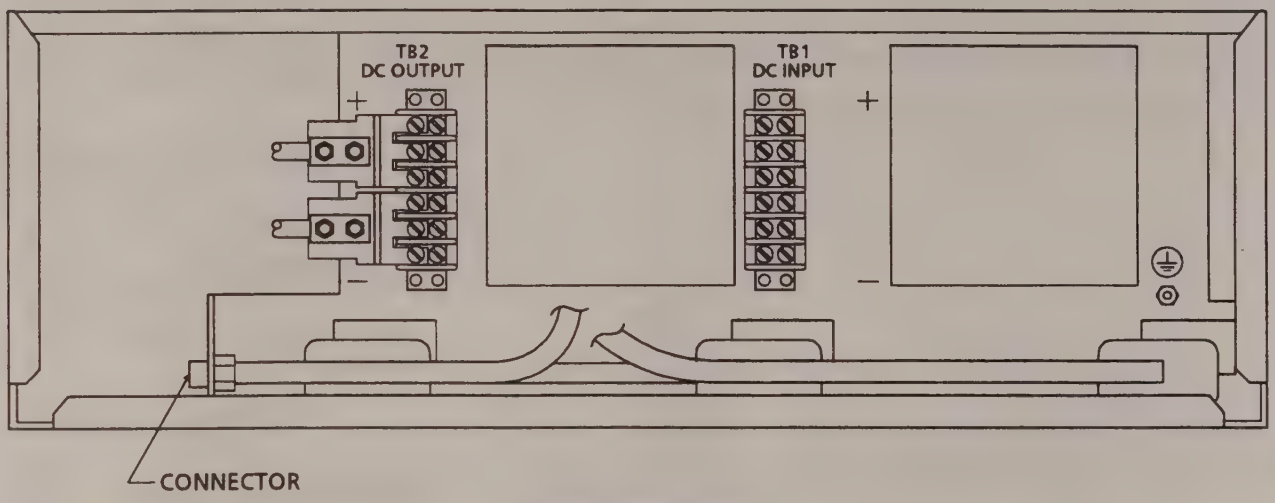


L. SIDE VIEW

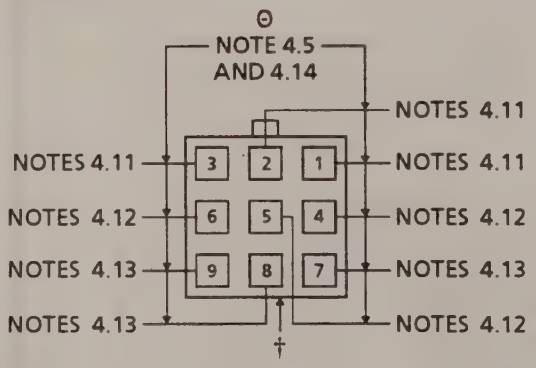
NOTES :

1. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
2. WEIGHT IN LBS. (CABINET)
   NET : 20.0
   SHIPPING : 25.0
3. WEIGHT IN LBS. (ONE MODULE)
   NET : 11.0
   SHIPPING : 13.0
4. FINISH : OFF WHITE.
5. INDICATES VENTILATING GRILLE

3. INSTALLER'S CONNECTIONS

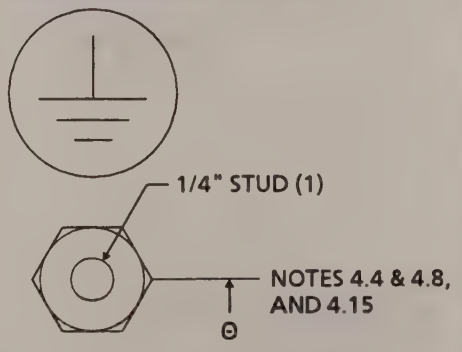


CABINET REAR VIEW
SHOWING CONNECTOR LOCATION

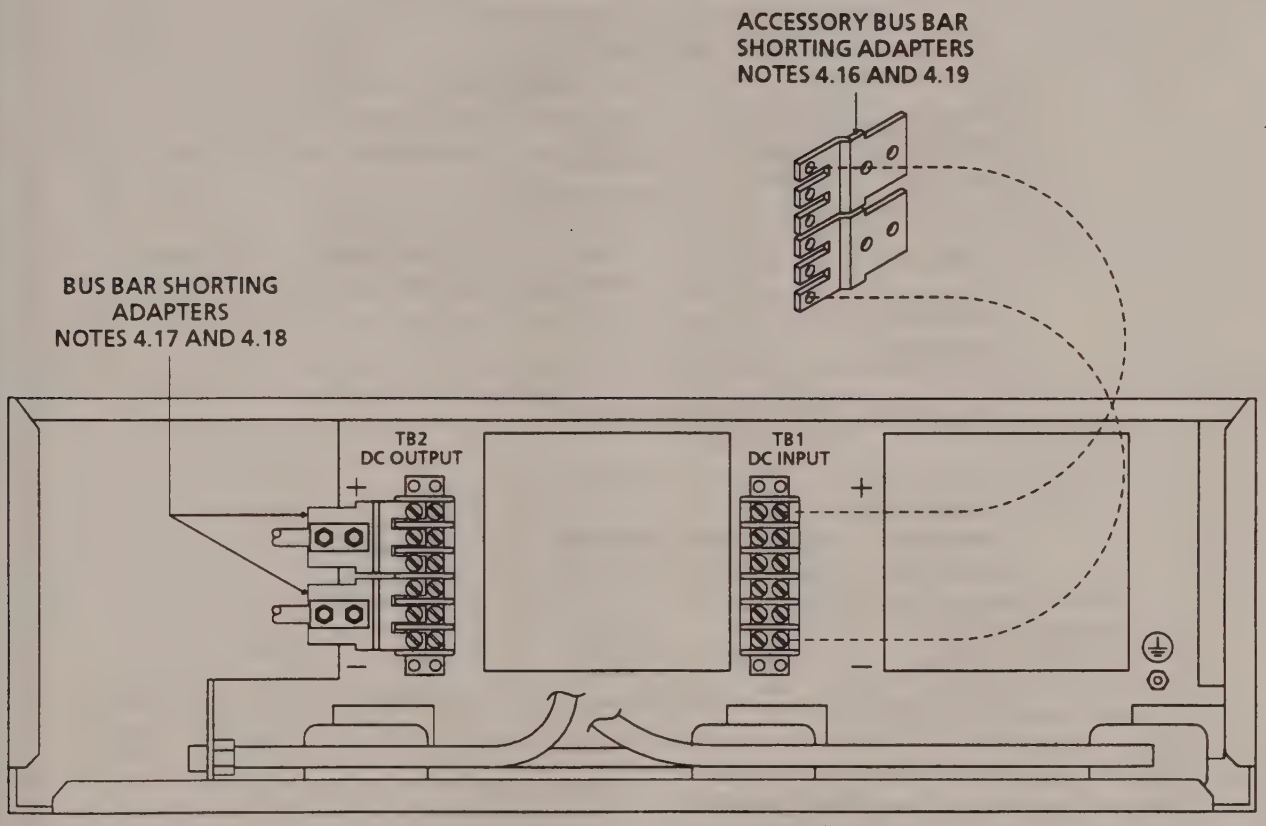


J4
ALARM AND CONTROL

FRAME GROUND TERMINAL
STUD PROVIDED FOR INSTALLATION
OF CUSTOMER FURNISHED LUG. SEE
NOTE 4.4 FOR RECOMMENDED LUG SIZE



3. INSTALLER'S CONNECTIONS



4. INSTALLER'S INFORMATIONS NOTES

4.1 DC Input: The tables below list the recommended wire sizes for single module wiring. For wire sizing information on paralleling inputs and/or outputs refer to the crimp and compression lug tables located later in this Power Data Sheet.

4.2

DC INPUT (Wiring For One Module) TB1 (NOTE 4.6)			
Recm Wire Size (Note 4.10)	Loop Length (Ft) (Note 4.9)	Recm Fusing	Capacity
8 Ga.	46	40 Amperes	8 Ga. Max

4.3

DC OUTPUT (Wiring For One Module) TB2 (NOTE 4.7)		
Recm Wire Size (Note 4.10)	Loop Length (Ft) (Note 4.9)	Capacity
14 Ga. 12 Ga. 10 Ga.	30 49 78	8 Ga. Max

4.4

FRAME GROUND TB3		
Terminal		Recm Wire Size (Note 4.10)
Capacity	Type	
-	1/4 x 20 Stud	6 Ga. Max

4.5

ALARM (J4)			
Terminals		Loop Length (Ft.)	Recm. Wire Size (Note 4.10)
Capacity	Type		
18 Ga. Max.	Locking Plug	0 - 200	22 Ga.
		over 200	18-20 Ga.

4. INSTALLER'S INFORMATIONS NOTES

4.6 DC Input: Terminal Block (TB1) is provided for installation of customer furnished DC input lugs. The tables below list the recommended crimp or screw type pressure lugs for the various recommended wire sizes. The tables below are for use only when wiring all <u>three</u> DC Outputs in parallel using the optional bus bar shorting adapter.

DC INPUT (TB1) SCREW TYPE COMPRESSION LUG (**Three Modules** connected in parallel)				
Recm Wire Size (Note 4.10)	Loop Length (Ft) (Note 4.9)	Recommended Lug		Capacity Of Adapter
		Vendor(s)	Part No.	
2 Ga.	59	LORAIN	245632900	2 Ga. To 1/0 Ga. Max

DC INPUT - CRIMP LUG TB1 (**Three modules** connected in parallel) (Recm. Fusing - 125 Amperes)					* Crimp Tool Required T & B Model TBM12 OR TBM15 Hydraulic Heads		
Recm Wire Size (Note 4.10)	Loop Length (Ft) (Note 4.9)	Wire Stranding Class	Recommended Lug				
			Vendor(s)	Part No.	Color Key	Die Index/ Code No.	Die Cat. Number
2 Ga.	59	B	T & B	54207	Brown	33	15528
			Burndy	YA2CL-2TC14			
		I	T & B	N/A	Pink	42	15508
			Burndy	YA25L-2TC14			

* The lugs should be crimped to the specifications given in the manufacturer's instructions furnished with the crimp tool or lug.

4. INSTALLER'S INFORMATIONS NOTES

4.7 DC Output: Terminal Block (TB2) is provided for installation of customer furnished DC output lugs. The tables below list the recommended crimp or screw type pressure lugs for the various recommended wire sizes. These tables are for use when wiring all <u>three</u> DC Outputs in parallel using the optional bus bar shorting adapter.

DC OUTPUT - SCREW TYPE COMPRESSION LUG (**Three modules** connected in parallel)				
Recm Wire Size (Note 4.10)	Loop Length (Ft) (Note 4.9)	Recommended Lug		Capacity
		Vendor(s)	Part No.	
10 Ga. 8 Ga. 6 Ga.	39 62 98	LORAIN	245630900	14 to 6 Ga.

DC OUTPUT - CRIMP LUG (**Three modules** connected in parallel)					* Crimp Tool Required T & B Model TBM12 OR TBM15 Hydraulic Heads		
Recm Wire Size (Note 4.10)	Loop Length (Ft) (Note 4.9)	Wire Stranding Class	Recommended Lug				
			Vendor(s)	Part No.	Color Key	Die Index/ Code No.	Die Cat. Number
10 Ga.	39	B	Burndy	YAV10-R3 BOX	- 1	-1	-1
		I	T & B	54850BE	Red	21	15520
			Burndy	YA27L-2TC38			
8 Ga.	62	B	T & B	54850BE	Red	21	15520
			Burndy	YA27L-2TC38			
		I	T & B	54205	Blue	24	15522
			Burndy	YA6CL-2TC14			
6 Ga.	98	B	T & B	54205	Blue	24	15522
			Burndy	YA6CL-2TC14			
		I	T & B	54206	Grey	29	15527
			Burndy	YA4CL-2TC14			

* The lugs should be crimped to the specifications given in the manufacturer's instructions furnished with the crimp tool or lug.

- 1 Use T & B Model WT-1300 Shure Stake Hand Crimp Tool.

4. INSTALLER'S INFORMATION NOTES

4.8 Frame Ground: Threaded studs are provided for installation of a customer furnished frame ground lug. The tables below list the recommended screw-type compression lugs and crimp lugs for the recommended wire size.

FRAME GROUND - SCREW TYPE COMPRESSION LUG (TB3)			
Recm Wire Size (Note 4.10)	Recommended Lug		Capacity
	Vendor(s)	Part No.	
6 Ga.	LORAIN	245612600	2 To 8 Ga.

FRAME GROUND - CRIMP LUG (TB3)						
Recm Wire Size (Note 4.10)	Wire Stranding Class	Recommended Lug		Crimp Tool Required [1]		
		Vendor(s)	Part No.	Color Key	Die Index/ Code No.	Die Cat. Number
6 Ga.	B	T & B	54105	Blue	24	15522
		Burndy	YA6C-L-BOX			
	I	T & B	54106	Grey	29	15527
		Burndy	YA4C-L-BOX			

[1] The lugs should be crimped to the specifications given in the manufacturer's instructions furnished with the crimp tool or lug.

4. INSTALLER'S INFORMATION NOTES

4.9 The DC input/output wire sizes listed are sufficient to restrict voltage drop to 1.0 volt or less at rated full load output current for the loop lengths shown. Loop length is the sum of the lengths of the positive and negative leads. If a lead larger than specified is required due to loop length/voltage drop requirements, the installer should splice the larger lead to the wire connected to the equipment terminals.

4.10 Wire sizes based on recommendations of the National Electrical Code Table 310-16 for copper wire at 90°C conductor temperature, operating in ambient of 30°C. For operation in ambient higher than 30°C, apply derating factors listed in Table 310-16 of the National Electrical Code.

4.11 During normal operation of Converter Module 1, positive battery (ground) is provided at terminal 1 of J4, and positive battery (ground) is removed from terminal 3 of J4. If Converter Module 1 fails, positive battery (ground) is removed from terminal 1 of J4, and positive battery (ground) is provided at terminal 3 of J4.

4.12 During normal operation of Converter Module 2, positive battery (ground) is provided at terminal 4 of J4, and positive battery (ground) is removed from terminal 6 of J4. If Converter Module 2 fails, positive battery (ground) is removed from terminal 4 of J4, and positive battery (ground) is provided at terminal 6 of J4.

4.13 During normal operation of Converter Module 3, positive battery (ground) is provided at terminal 7 of J4, and positive battery (ground) is removed from terminal 9 of J4. If Converter Module 3 fails, positive battery (ground) is removed from terminal 7 of J4, and positive battery (ground) is provided at terminal 9 of J4.

4.14 If extended open and closed loop alarm circuits are desired (instead of positive battery), disconnect, sleeve, and tie back the brown wire connected to J4, terminal 2 (module one); the white wire connected to J4, terminal 5 (module two) and the yellow wire connected to J4, terminal 8 (module three). Positive battery is no longer provided at terminals 2 and 5 of J4. Extended form C alarm relay contacts of Converter Modules 1, 2 and 3 are now available at terminals of J4 as shown in the following table.

Converter Designation	Contact Status During Normal Converter Operation (Relay Energized)		Contact Status During Converter Failure Condition (Relay Released)	
	Open	Closed	Open	Closed
Module 1	TB4- 2 to TB4-3	TB4-1 to TB4-2	TB4-1 to TB4-2	TB4-2 to TB4-3
Module 2	TB4-5 to TB4-6	TB4-4 to TB4-5	TB4-4 to TB4-5	TB4-5 to TB4-6
Module 3	TB4-8 to TB4-9	TB4-7 to TB4-8	TB4-7 to TB4-8	TB4-8 to TB4-9

4. INSTALLER'S INFORMATION NOTES

4.15 If grounding of the converter chassis is required, connect a 6 Ga. wire from the FRAME GROUND connector to earth ground. Equipment grounding conductor size is based on recommendation of National Electrical Code Table 250-95 for copper wire. If aluminum or copper clad aluminum grounding conductor is used, refer to Table 250-95 for increased conductor size.

4.16 Converter cabinet is shipped wired for independent converter module DC inputs. For paralleled inputs connect one accessory shorting adapter between positive (+) inputs of Converter Module 1, Converter Module 2 and Converter Module 3. Connect the other accessory shorting adapter between negative (-) inputs of Module 1, Module 2 and Converter Module 3.

4.17 Converter cabinet is shipped wired for paralleled converter module DC outputs. For independent outputs, remove the furnished shorting adapter between positive (+) outputs of Converter Module 1, Converter Module 2 and Converter Module 3. Remove the other furnished shorting adapter between negative (-) outputs of Converter Module 1, Converter Module 2 and Converter Module 3.

4.18 Connect either the positive or negative output to the system grounded conductor. This connection must be made. The output cannot be left floating.

4.19 **SELV:** This product requires a Safety Extra-Low Voltage (SELV) Input. A SELV input (based on the safety requirements for Information Technology Equipment Standards, such as UL1950, IEC 950) is a secondary circuit which is so designed and protected that under normal and single-fault conditions, the voltage between any two parts of the SELV circuit or circuits and for Class I equipment (provided with a protective earthing conductor from the building), between any one such part and the equipment protective earthing terminal does not exceed a safe value (42.4 V peak or 60 Vdc under normal conditions). It is separated from the primary or mains supply by Double (insulation comprising both Basic and Supplementary insulation) or Reinforced insulation (a single insulation system which provides a degree of protection against electric shock equivalent to Double insulation).

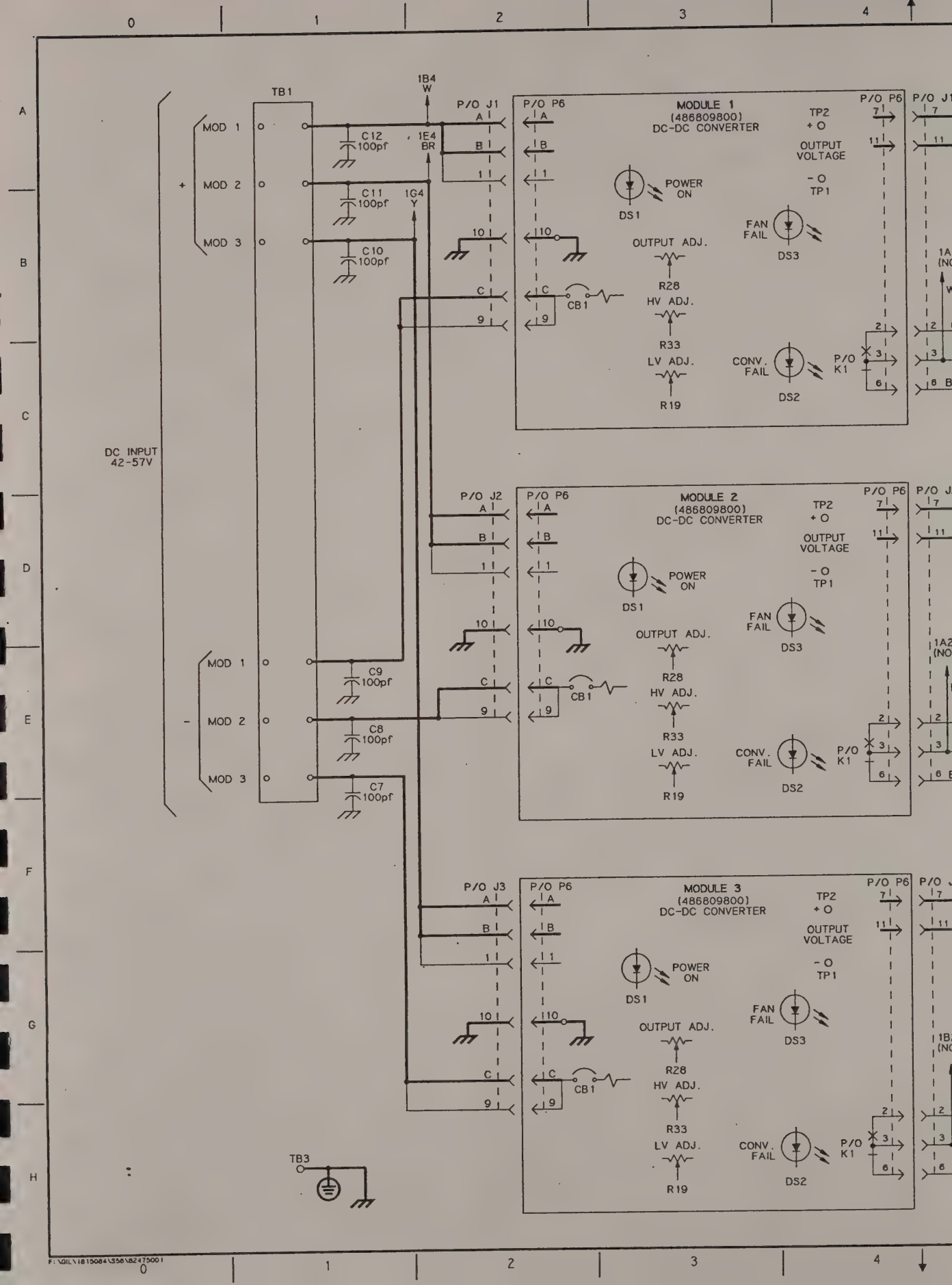
4.20 ⊖ - indicates leads furnished and connected by the installer.

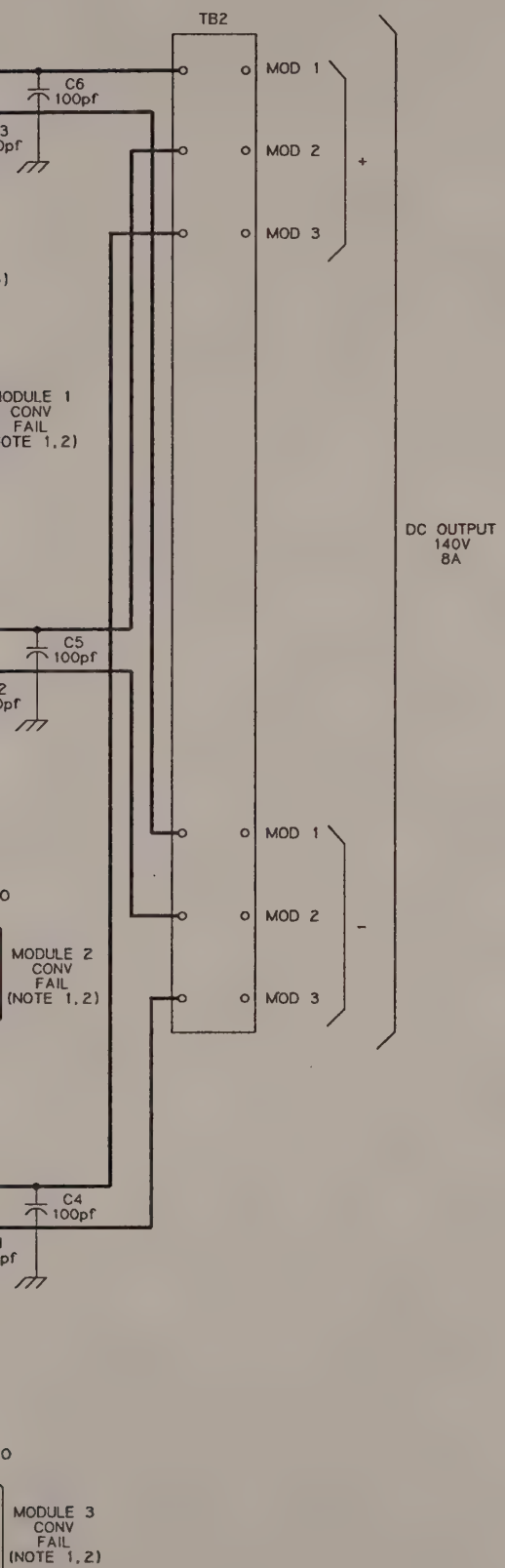
4.21 † - indicates mating connector to be furnished by the installer.

Mating connector Part No. - Amp 172169-1 (P4)

Mating Contact Part. No. - Amp 170362-3

Hand Crimp Tool Required - Amp 90711-1


TB1
1B4 W
1E4 BR
1G4 Y
DC INPUT 42-57V
+
-
MOD 1
MOD 2
MOD 3
C12 100pf
C11 100pf
C10 100pf
C9 100pf
C8 100pf
C7 100pf
P/O J1
P/O J2
P/O J3
P/O P6
MODULE 1 (486809800) DC-DC CONVERTER
MODULE 2 (486809800) DC-DC CONVERTER
MODULE 3 (486809800) DC-DC CONVERTER
TP2 + O
OUTPUT VOLTAGE
- O TP1
POWER ON
DS1
FAN FAIL
DS3
OUTPUT ADJ.
R28
HV ADJ.
R33
LV ADJ.
R19
CB1
CONV. FAIL
DS2
P/O K1
TB3

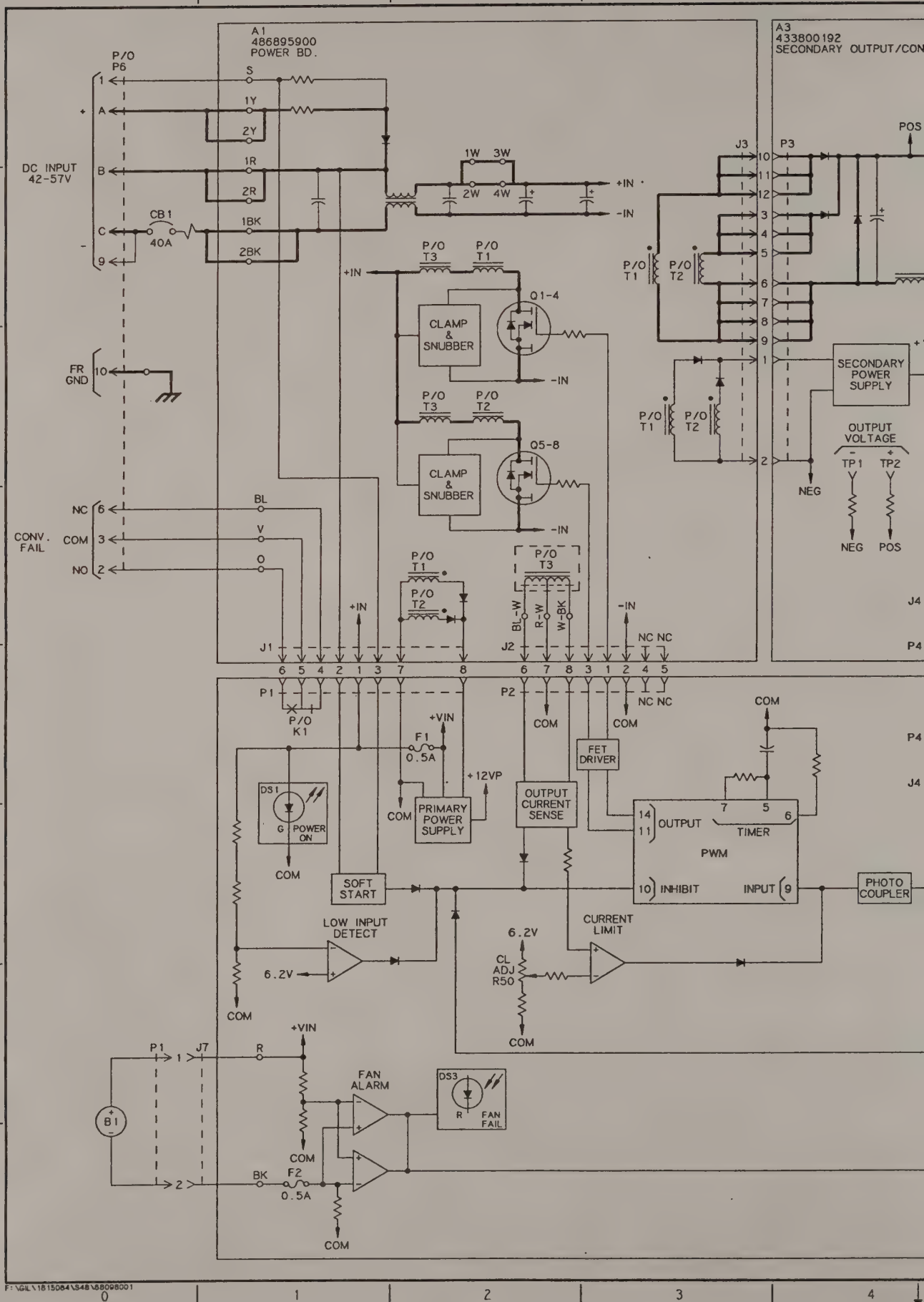


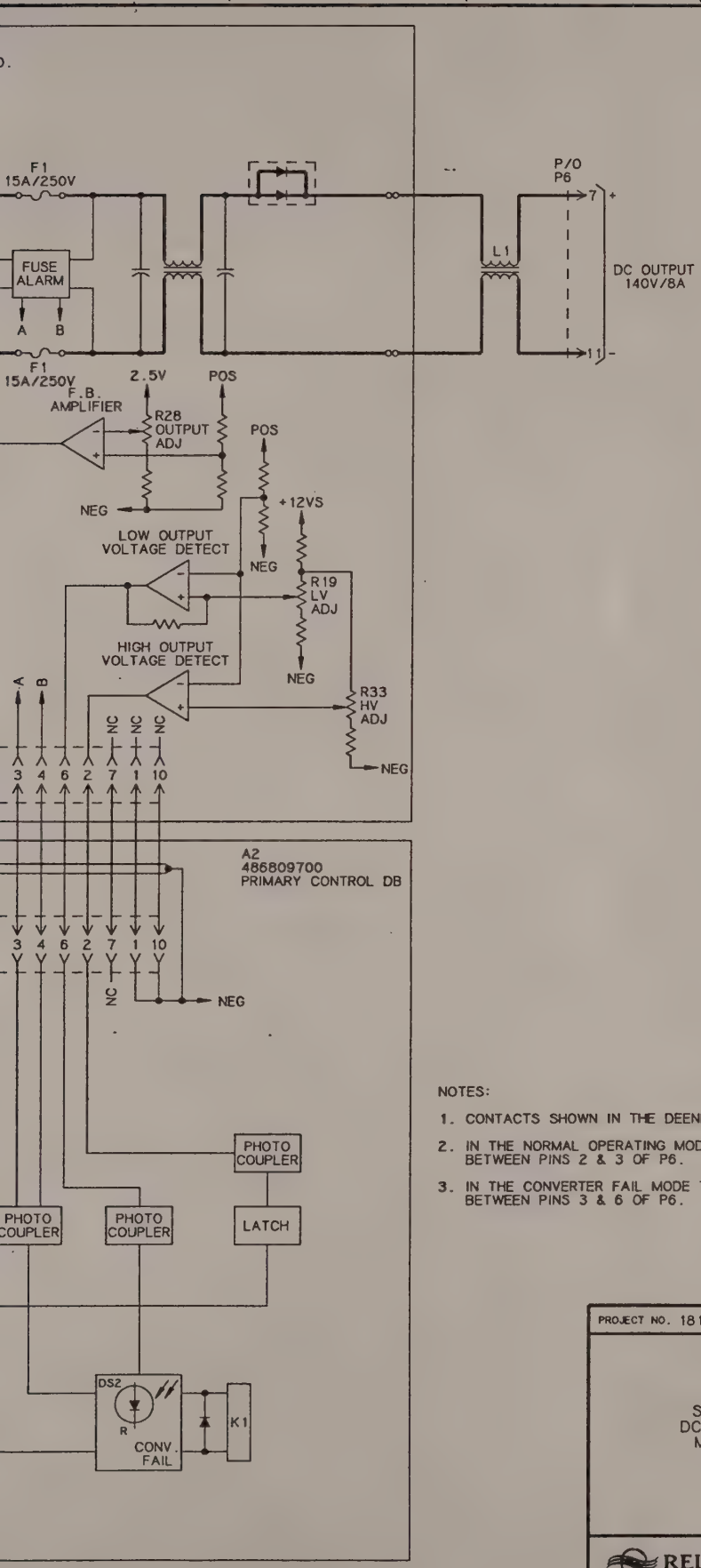
REVISION RECORD			
REV	PRN. NUMBER	DATE CHANGED	CHANGED BY
DESCRIPTION			APPD'C + ALS
A1	NEW APR 07 1997		

NOTES:

1. DURING NORMAL OPERATING CONDITIONS, POSITIVE INPUT IS PROVIDED ON J4-
   TERMINAL 1 FOR MODULE 1.
   TERMINAL 4 FOR MODULE 2.
   TERMINAL 7 FOR MODULE 3.
2. DURING FAILURE CONDITIONS, POSITIVE INPUT IS PROVIDED ON J4-
   TERMINAL 3 FOR MODULE 1.
   TERMINAL 6 FOR MODULE 2.
   TERMINAL 9 FOR MODULE 3.
3. POSITIVE INPUT IS PROVIDED AT J4-
   TERMINAL 2 FOR MODULE 1.
   TERMINAL 5 FOR MODULE 2.
   TERMINAL 8 FOR MODULE 3.
4. CONTACTS SHOWN IN THE DEENERGIZED POSITION.
5. REFER TO HSB24HCAB INSTRUCTION MANUAL FOR INFORMATION ON THE INSTALLATION AND ADJUSTMENT OF CONVERTER PLUG-IN ASSEMBLIES.
6. TO PROVIDE OPEN LOOP AND CLOSED LOOP CIRCUITS: REMOVE, INSULATE, AND TIE BACK WHITE WIRE ATTACHED TO TERMINAL 2 ON J4 FOR MODULE 1, BROWN WIRE ATTACHED TO TERMINAL 5 FOR MODULE 2, AND YELLOW WIRE ATTACHED TO TERMINAL 8 FOR MODULE 3. REFER TO HSB24HCAB INSTRUCTION MANUAL FOR INFORMATION ON OPEN AND CLOSED LOOPS.

PROJECT NO. 1815084	COMPUTER GENERATED DRAWING	B. GOODLIVE	A1
		G.R. FRIOUD	09-05-96
		B. Goodlive	4-7-97
		L.E. Mathe	4/4/97
SCHEMATIC DIAGRAM FOR CABINET ASSEMBLY MODEL HSB24HCAB		STANDARD	
		SD588247500	
RELTEC Lorain Products	D	SHEET 1 OF 1	


A1
486895900
POWER BD.
A3
433800192
SECONDARY OUTPUT/CON
P/O
P6
DC INPUT
42-57V
CB1
40A
FR
GND
CONV.
FAIL
NC
COM
NO
BL
V
O
P/O
T3
P/O
T1
P/O
T2
Q1-4
Q5-8
CLAMP
&
SNUBBER
+IN
-IN
J1
J2
J3
P3
P4
J4
P1
P2
P/O
K1
NC NC
BL-W
R-W
W-BK
SECONDARY
POWER
SUPPLY
OUTPUT
VOLTAGE
TP1
TP2
NEG
POS
POS
+VIN
F1
0.5A
+12VP
COM
DS1
G
POWER
ON
PRIMARY
POWER
SUPPLY
FET
DRIVER
OUTPUT
CURRENT
SENSE
PWM
OUTPUT
TIMER
INHIBIT
INPUT
PHOTO
COUPLER
SOFT
START
LOW INPUT
DETECT
6.2V
CURRENT
LIMIT
CL
ADJ
R50
B1
J7
FAN
ALARM
DS3
R
FAN
FAIL
F2
0.5A
BK



NOTES:

1. CONTACTS SHOWN IN THE DEENERGIZED POSITION.
2. IN THE NORMAL OPERATING MODE THERE IS A CLOSURE BETWEEN PINS 2 & 3 OF P6.
3. IN THE CONVERTER FAIL MODE THERE IS A CLOSURE BETWEEN PINS 3 & 6 OF P6.

REVISION RECORD

REV	PRN NUMBER	DATE CHANGED	CHANGED BY
DESCRIPTION			APPROVALS
A1	NEW	APR 07 1997	BP

FIRST USED ON:

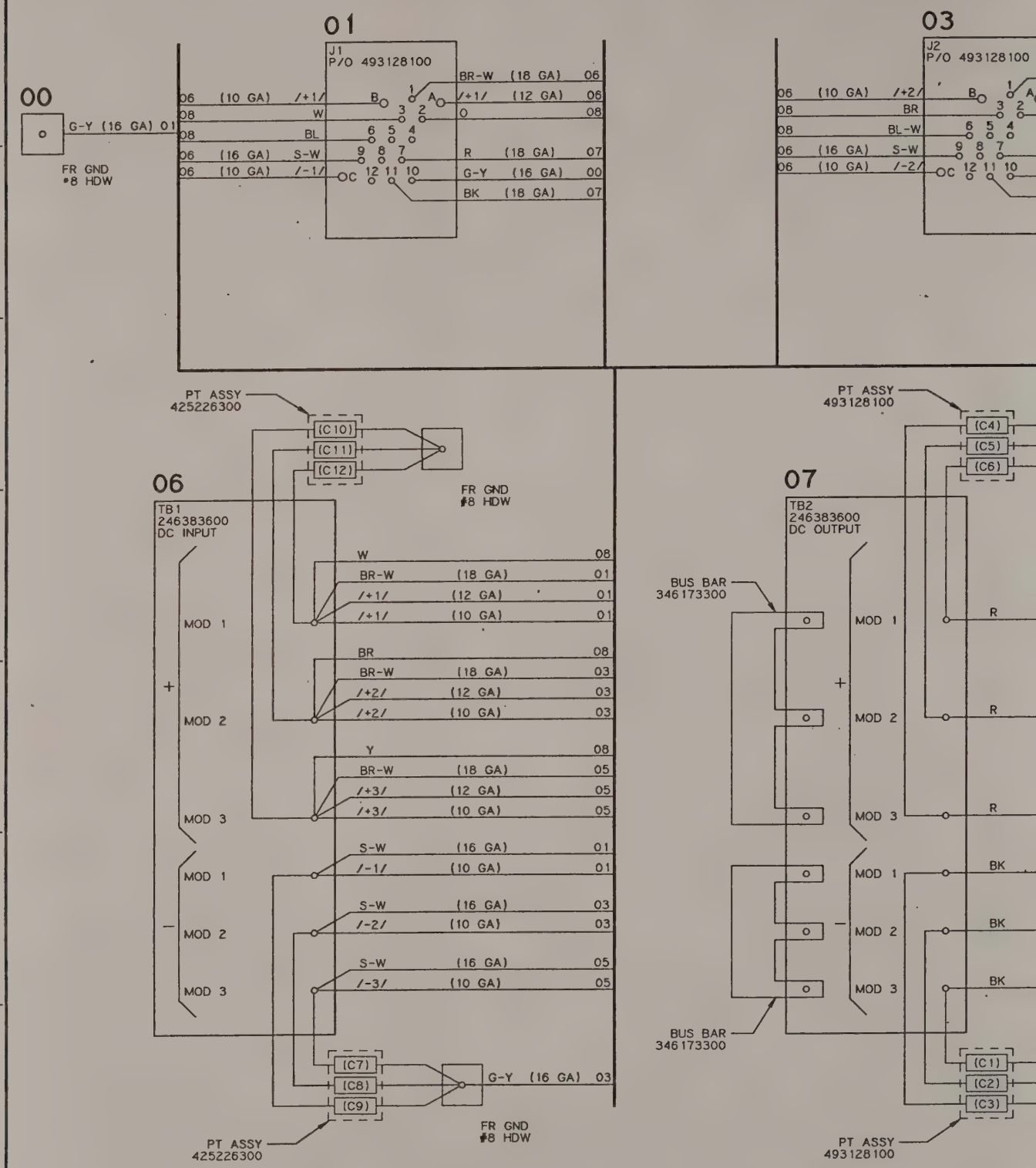
PROJECT NO. 1815084 | COMPUTER GENERATED DRAWING

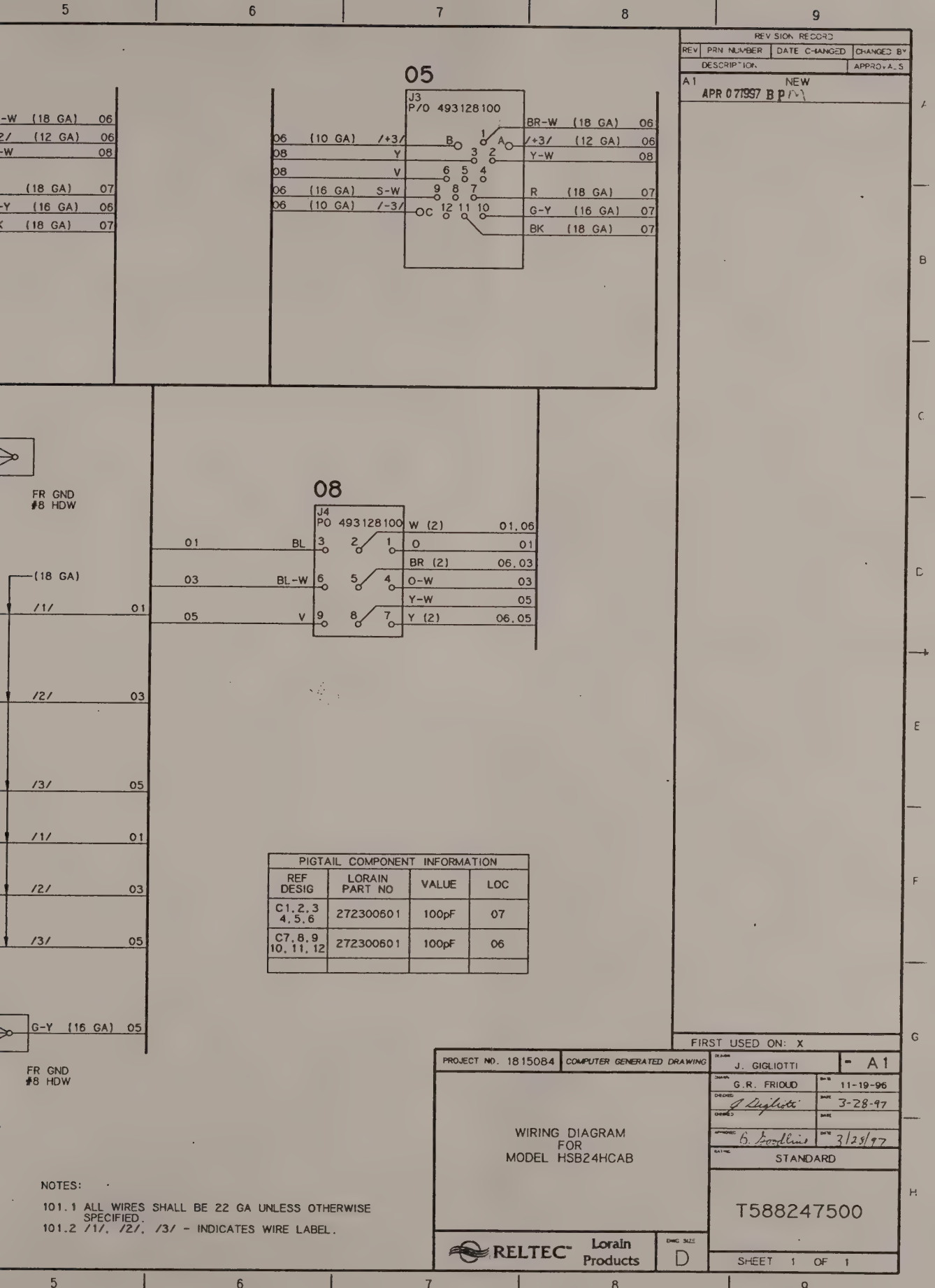
SCHEMATIC FOR
DC-DC CONVERTER
MODEL HSB8HM

DRAWN	B. GOODLIVE	A1
DESIGNED	G.R. FRIOUD	09-13-96
CHECKED	B. Goodlive	4-2-97
APPROVED	[signature]	4/4/97
QA/MFG	STANDARD	

SD486809800

RELTEC Lorain Products | SIZE D | SHEET 1 OF 1


00
G-Y (16 GA) 01
FR GND
#8 HDW
01
J1
P/O 493128100
06 (10 GA) /+1/ B
08 W 3
08 BL 6 5 4
06 (16 GA) S-W 9 8 7
06 (10 GA) /-1/ C 12 11 10
BR-W (18 GA) 06
/+1/ (12 GA) 06
O 08
R (18 GA) 07
G-Y (16 GA) 00
BK (18 GA) 07
03
J2
P/O 493128100
06 (10 GA) /+2/ B
08 BR 3
08 BL-W 6 5 4
06 (16 GA) S-W 9 8 7
06 (10 GA) /-2/ C 12 11 10
PT ASSY
425226300
(C10)
(C11)
(C12)
FR GND
#8 HDW
06
TB1
246383600
DC INPUT
W 08
BR-W (18 GA) 01
/+1/ (12 GA) 01
/+1/ (10 GA) 01
MOD 1
BR 08
BR-W (18 GA) 03
/+2/ (12 GA) 03
/+2/ (10 GA) 03
MOD 2
Y 08
BR-W (18 GA) 05
/+3/ (12 GA) 05
/+3/ (10 GA) 05
MOD 3
S-W (16 GA) 01
/-1/ (10 GA) 01
MOD 1
S-W (16 GA) 03
/-2/ (10 GA) 03
MOD 2
S-W (16 GA) 05
/-3/ (10 GA) 05
MOD 3
(C7)
(C8)
(C9)
G-Y (16 GA) 03
PT ASSY
425226300
FR GND
#8 HDW
PT ASSY
493128100
(C4)
(C5)
(C6)
07
TB2
246383600
DC OUTPUT
BUS BAR
346173300
MOD 1
MOD 2
MOD 3
R
R
R
MOD 1
MOD 2
MOD 3
BK
BK
BK
BUS BAR
346173300
(C1)
(C2)
(C3)
PT ASSY
493128100



PIGTAIL COMPONENT INFORMATION			
REF DESIG	LORAIN PART NO	VALUE	LOC
C1, 2, 3 4, 5, 6	272300601	100pF	07
C7, 8, 9 10, 11, 12	272300601	100pF	06

NOTES:

101.1 ALL WIRES SHALL BE 22 GA UNLESS OTHERWISE SPECIFIED.
101.2 /1/, /2/, /3/ - INDICATES WIRE LABEL.

REVISION RECORD			
REV	PRN NUMBER	DATE CHANGED	CHANGED BY
DESCRIPTION			APPROVALS
A1	NEW	APR 07 1997	B P

FIRST USED ON: X

PROJECT NO. 1815084 | COMPUTER GENERATED DRAWING

DRAWN J. GIGLIOTTI - A1

CHECKED G.R. FRIOUD 11-19-96

ENGR J. Gigliotti 3-28-97

APPROVED G. Foodline 3/25/97

RATING STANDARD

WIRING DIAGRAM
FOR
MODEL HSB24HCAB

T588247500

RELTEC Lorain Products

DWG SIZE D

SHEET 1 OF 1

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PARTS (CUSTOMER SERVICE)	800-927-2780
PARTS FAX	800-927-2781
DEPOT REPAIR	800-978-8810
TRAINING	800-398-8867

FIELD SUPPORT LOCATIONS

For Field Service Dispatch (Cleveland, OH) 800-800-5260

CALIFORNIA
Los Angeles, Sacramento, San Jose

COLORADO
Denver

CONNECTICUT
Hartford

FLORIDA
Miami, Orlando

GEORGIA
Atlanta

ILLINOIS
Chicago

INDIANA
Indianapolis

MARYLAND
Baltimore

MICHIGAN
Detroit

MINNESOTA
Minneapolis

MISSOURI
Kansas City

NEW JERSEY
Moorestown

NEW YORK
Syracuse

NORTH CAROLINA
Raleigh/Durham

OHIO
Cleveland

TENNESSEE
Memphis

TEXAS
Dallas, Houston

WASHINGTON
Seattle

WISCONSIN
Madison

CANADA
122 Edward Street
St. Thomas, Ontario, Canada
N5P 1Z2
Telephone: 519/631-0780
FAX: 519/631-0359

MEXICO
S.A. de C.V.
Apartado Postal 77001
Mexico, 10 D.F. MX 11200
Telephone: (5) 576-8277
FAX: (525) 358-7195

UNITED KINGDOM
Unit D8, West Entrance
Fairoaks Airport
Chobham, Woking
Surrey, UK GU24 8HU
Telephone: 44) 1276 855 627

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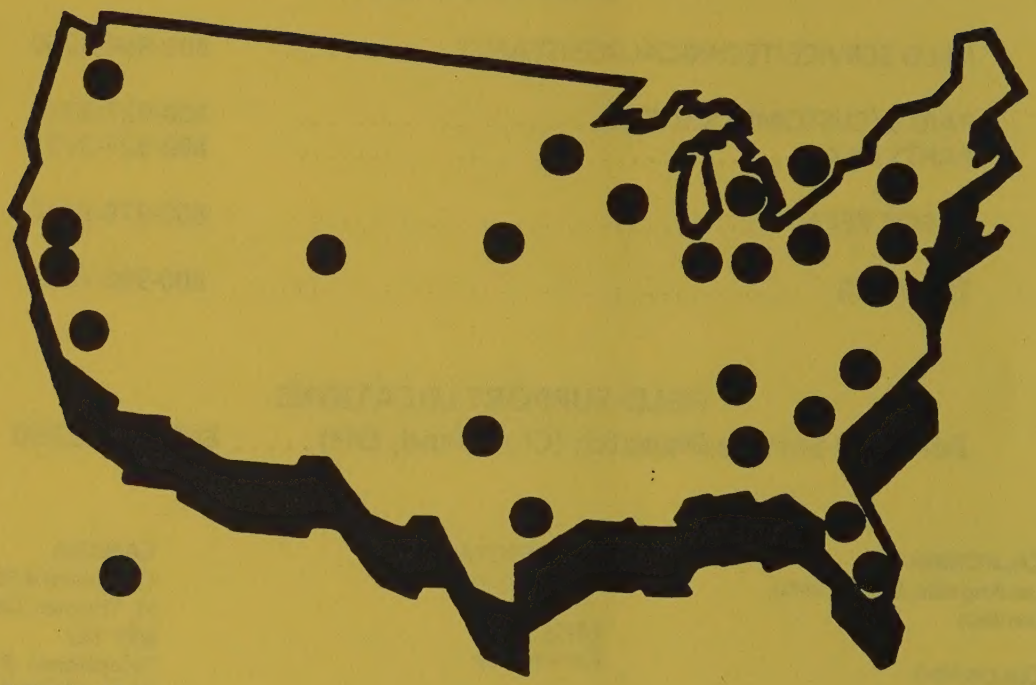

RELTEC SERVICES CAN ALSO PROVIDE:

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- ★ PARTS KITS AND FUSE KITS
- ★ DEPOT REPAIR
- ★ MAINTENANCE CONTRACTS
  - Power Equipment
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  - Factory
  - Customer Site
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- ★ SPECIALIZED TEST EQUIPMENT
  - Ringing Generator Test Set- Model LS2000 (Includes loads, metering, digital frequency counter)
  - Load Simulators - 25V, 50V, and 130V
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PARTS (CUSTOMER SERVICE)	800-927-2780
PARTS FAX	800-927-2781
DEPOT REPAIR	800-978-8810
TECHNICAL ASSISTANCE	800-959-7090
TRAINING	800-398-8867
In Canada	
RELTEC CANADA	519-645-9440